CONSERVING BIODIVERSITY IN THE CANARY ISLANDS

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Abstract

The flora of the Canary Islands is rich in endemic species and shows typical insular evolutionary features, such as large-scale adaptive radiation (*Echium*, *Sonchus*, *Argyranthemum*, *Aeonium*) and interisland vicariance. It is also a relict flora of the Tertiary Epoch of the Mediterranean Region and the drier regions of Africa, and as such has enormous scientific value. Many taxa (e.g., *Olea europaea* subsp. *cerasiformis*, *Brassica bourgaei*) are valuable economic plants or close relatives whose conservation is of considerable importance. Locally, action has been taken on various levels to provide protection, especially for natural areas. This involves major legislation (Ley de Espacios Naturales), planning via a series of "Planes Especiales para Protección de Espacios Naturales," and establishment of national parks, biosphere reserves, and a World Heritage Site. This is supported by intensive research on endangered species involving studies of genetic diversity, population biology, breeding systems, resource evaluation, micropropagation, and restoration of some ecosystems. Some of the theoretical and practical difficulties encountered in this field are noted. The role of local botanical gardens in planning, conservation-oriented research, and the extremely important field of environmental education is explained, and the value of the garden as the interface between ex situ and in situ conservation is considered.

Since the middle of last century, when Charles Darwin published the remarkable conclusions drawn partly from his observations on the fauna and flora of the Galápagos Archipelago, islands have fascinated scientists because they are natural biological and evolutionary laboratories where evolution in isolation has permitted the survival of rare, relict endemic taxa and at the same time promoted the formation of new, often equally rare and interesting ones.

Islands, therefore, can provide a novel and invaluable scientific resource. Particularly when we are concerned with the conservation of small populations and the protection of very rare species, there are many theoretical and practical conservation lessons to be learned from island systems. This is especially true for the fields of population genetics and behavior.

Recent research, such as that carried out on Hawaiian organisms during IBP (International Biological Program) "Integrated Island Ecosystems Program," suggests that, contrary to widespread popular belief, the genetic properties of island populations are essentially similar to those of continental ones (see Carson, 1981, for full discussion of this subject). This is confirmed by work on Canarian groups, such as *Lotus*, where the range of karyotype variation and cyanogenic properties closely parallels that reported from continental European species (Ortega, 1978; Urbanska & Willdi, 1975). Thus, concepts derived from the study of the behavior of small isolated populations from islands should be even more applicable to rare and endangered continental species than suspected before the IBP research.

Islands, however, are very vulnerable to ecological change, especially the disruptive and destructive alteration brought about by human interference in insular ecosystems, the direct effects of humans and those of domestic animals and plants as well as their camp followers, weeds and pests. The *IUCN Plants Red Data Book* or the recently published *Plants in Danger: What Do We Know?* (Davis et al., 1986) reveal how many ecosystems and species are currently threatened on islands (Table 1).

Biodiversity in the Canary Islands

From the islands conservation point of view, the Canaries are no exception. The archipelago of seven main islands and several small islets and rocks covers over 7,250 km^2 with a population of some 1.5 million (approximately 206 people per km^2). The total flora, which is taxonomically well known, is about 2,000 species with just over 500 endemics, i.e., 25% endemism. The total figure, however, includes a number of weeds and aliens. Endemism is probably between 35% and 45% of the native flora. For such a small area, this is a remarkable

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TABLE 1. Small oceanic islands with devastated floras. Ex extinct, E endangered, V vulnerable, R rare, I indeterminate, K insufficiently known, nt not threatened.

	Ex	E	V	R	I	K	nt	Total	Rare or threatened
Ascension Island	1	5	–	4	–	1	–	11	10 (91%)
Bermuda	3	4	1	6	–	?	?	?	14
Norfolk Island	5	11	29	–	1	2	–	48	46 (96%)
Rodrigues	10	20	8	8	–	–	2	48	46 (96%)
St. Helena	7	23	–	17	–	2	–	49	47 (96%)

degree of diversity and endemism. The total flora is larger than that of the British Isles, where the area is almost 34 times that of the Canary Islands.

Although over 67% (383) of the endemic species are rare, threatened, or endangered (Fig. 1), most are extremely tenacious and capable of hanging on in precarious circumstances over long periods. Since the first relatively comprehensive accounts of the flora were published last century (Webb & Berthelot, 1836–1850; Sauer, 1880) only a single species, *Solanum nava*, has not been found again during the last 20 years. Areas of good natural vegetation, on the other hand, have been decimated over the past 500 years and especially in recent decades.

The flora of the Canary Islands is of particular interest for a number of reasons, and the arguments for its conservation are scientifically and economically strong.

Paleobotanical and biogeographical data suggest that it is historically a relict flora (Bramwell, 1972, 1976, 1985). Its closest relatives are in either the Tethyan–Tertiary Region along the edges of the Tethys Sea, principally in the late Miocene and Pliocene periods, or along the drier margins of eastern and southern Africa, the Arabian Peninsula, and Socotra as a relict of a once more widespread semidesert flora of the pre-Holocene (Quezel, 1978; Bramwell, 1985). The islands are now isolated from their main source areas by time, by sea, and by desert. This has resulted in a postisolation phase of evolution with adaptive radiation and vicariance leading to two main types of endemic taxa: the relicts that have not undergone speciation on a large scale (*Dracaena*, *Bosea*), and the active epibiotics (Bramwell, 1972), which at the generic level are probably relicts (*Aeonium* found in Macaronesia and East Africa, for example) but have a plethora of local endemic species due to adaptive radiation. In fact, in *Echium*, *Sonchus*, *Argyranthemum*, and *Aeonium*, we have some of the finest examples of plant adaptive radiation on islands anywhere (Lems, 1960; Bramwell, 1972, 1975; Humphries, 1976; Aldridge, 1979). These evolutionary models merit conservation in as complete a state as possible since every species that becomes extinct breaks a link in the chain and makes our understanding of the processes, patterns, and products of their evolution more difficult.

Many of these Canarian endemics survive in very small populations and have, according to the literature, done so for over a century (Cabrera y Diaz, 1910) so that there may be much to learn from their genetics, population structure, and the roles of dormant individuals held in the natural seed reservoir in maintaining long-term variability and fitness. This, coupled with the scientific interest of the flora, is a valid reason for conservation of such model floras.

There are, however, other reasons for concern for the conservation of the Canarian flora. Because

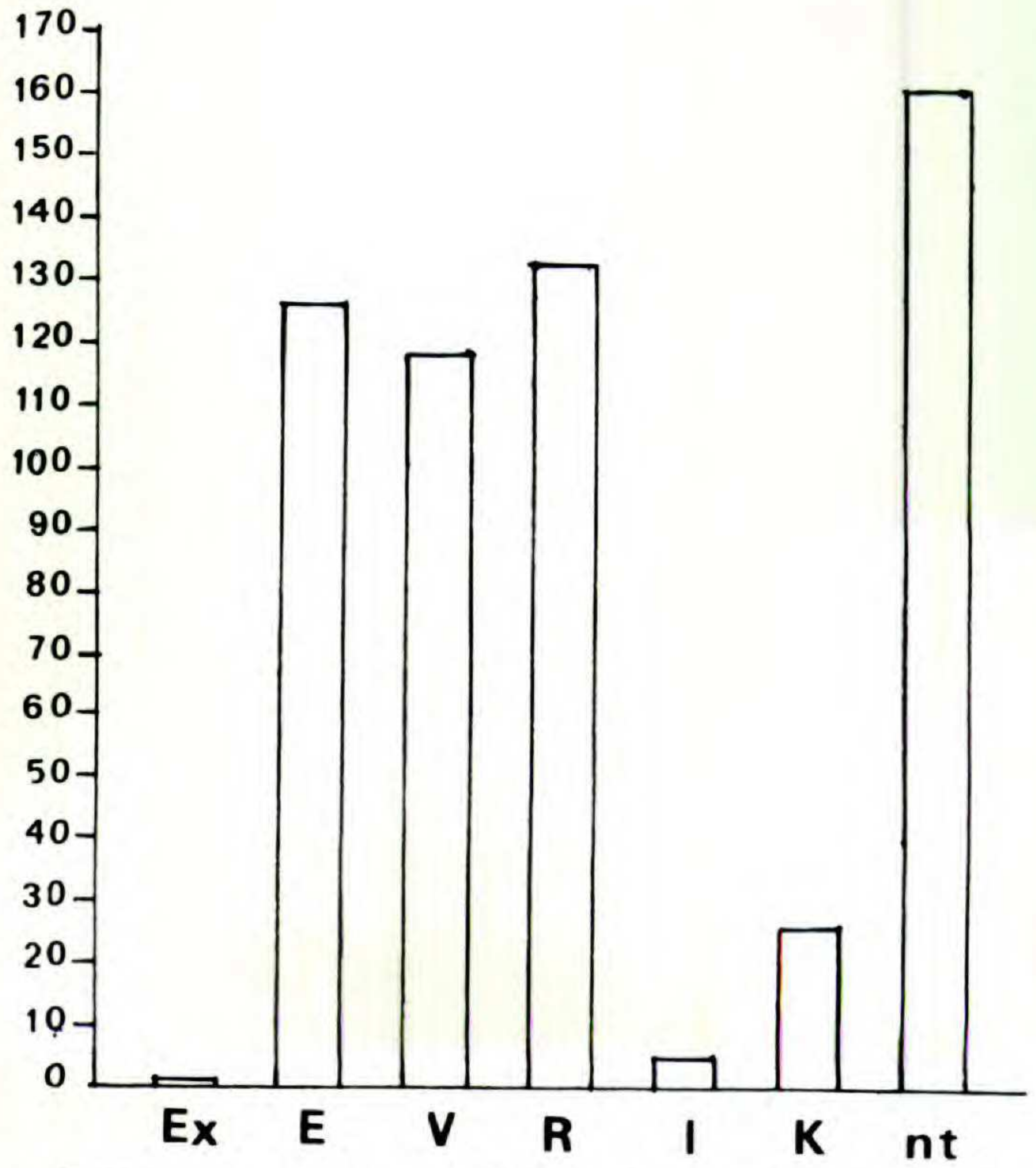

FIGURE 1. Threatened endemic plant species of the Canary Islands assigned to IUCN Categories. Ex extinct, E endangered, V vulnerable, R rare, I indeterminate, K insufficiently known, nt not threatened.

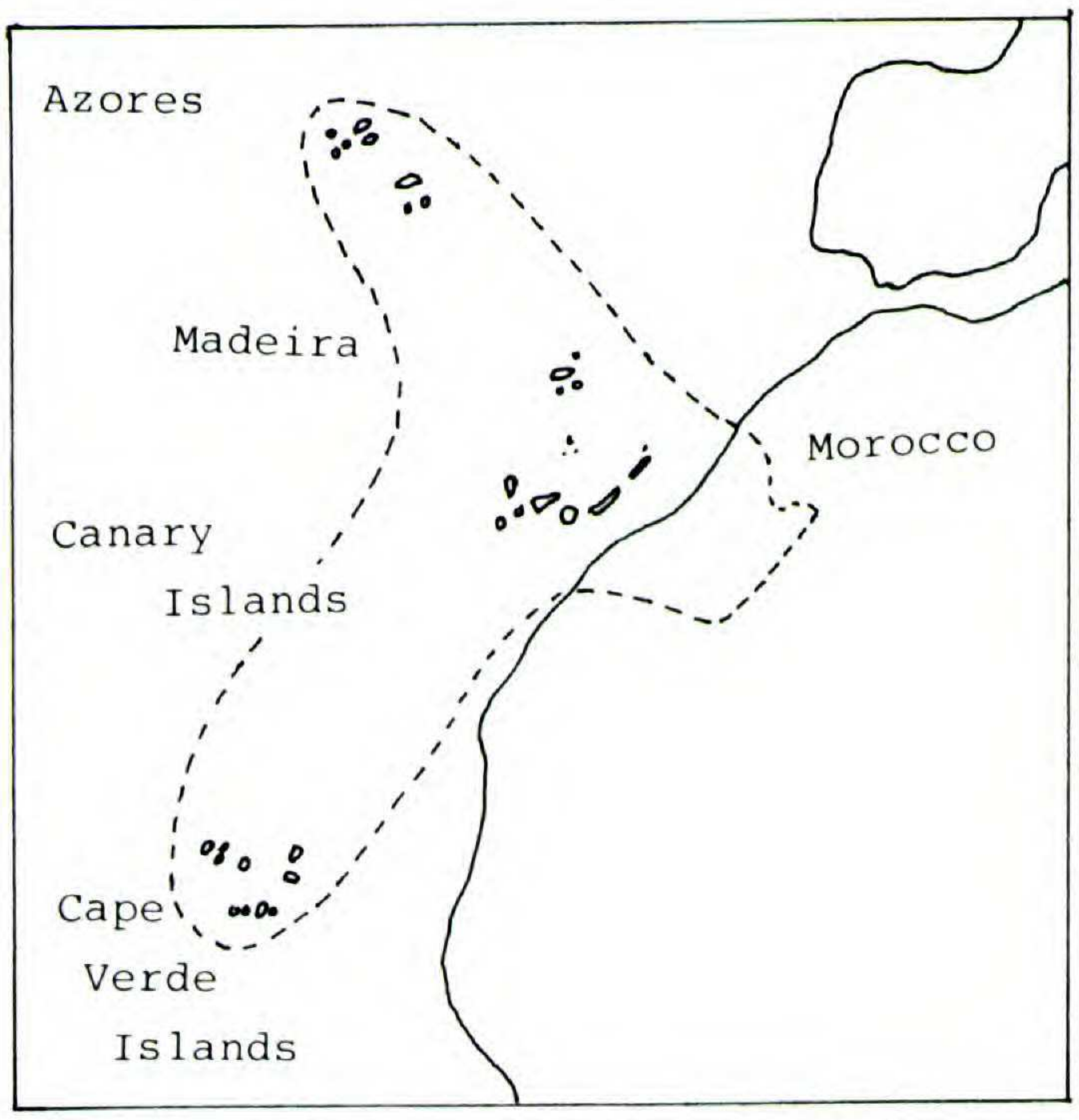

FIGURE 2. The geographical situation of the Canary Islands. — Limit of the Macaronesian Region.

of its historical association with the old Mediterranean floras of the Tethyan–Tertiary, the Canarian flora has a number of wild relatives of classical Mediterranean economic plants and crops; among the most important of these are *Olea europaea* subsp. *cerasiformis*, *Phoenix canariensis*, *Brassica bourgaei*, *Cytisus proliferus*, *Beta webbiana*, *Avena canariensis*, and *Dactylis smithii*.

To species such as these we can add a long list of potentially valuable ornamental species in such genera as *Argyranthemum*, *Limonium*, *Lotus*, and *Senecio* sect. *Pericallis* (endemic to Macaronesia and with the vast majority of species local endemics in the Canaries) which is the Florist's Cineraria. there are also many local medicinal uses for endemic species but, although some of these have been the subject of a recent review (Perez de Paz & Medina, 1988), their active constituents have not in most cases been studied in detail.

The major vegetation types and plant communities of the islands are endemic to the Canaries or in some cases to the Macaronesian Region (Fig. 2). These include a *Euphorbia* scrub zone (dominated by *Euphorbia broussonetii*, *E. aphylla*, *E. canariensis*, and other species), which is similar to some North and East African communities; the humid laurel forests in which all the dominant trees are endemic to the Macaronesian Region and are relicts of the Tethyan–Tertiary Region of approximately 4 million years ago; montane forests of the locally endemic pine, *Pinus canariensis*, which has its nearest relatives as Tertiary Mediterranean fossils and as the extant species *P. roxburghii* in the West Himalayas. The subalpine zone of the islands occurs only on Tenerife and La Palma and has over 90% endemism among the perennial plants; it shows morphological and physiological similarities to the Afro-Alpine zone of East Africa.

CONSERVATION PROBLEMS IN THE CANARY ISLANDS

Before the Spanish occupation in the fifteenth century, the Canary Islands were inhabited by a people, variously known as Guanches or Canarios, with a relatively simple neolithic culture who seem to have lived in relative harmony with their natural environment. After the fifteenth century, however, the situation changed considerably, especially when sugar cane was introduced to the islands and large areas of land were cleared for its cultivation. Forests were cut down to provide space and to fuel the sugar extraction and refining. As Ayensu et al. (1984) pointed out, "The natural vegetation of these islands was further affected, often totally destroyed, by the cultivation of tomatoes and grapevines, the terracing of the slopes for these and other vegetable crops, the widespread cultivation of bananas in coastal zones, and the introduction and spread of many Mediterranean weeds. This all led to a lowering of the water table and increased aridity." This proceeded over 500 years to such an extent that the laurel forest of Gran Canaria now covers less than 1% of its original area (Fig. 3) and on the island of Tenerife, less than 10% of its former extent.

From this brief summary of the recent history of the environment in the islands we can see that the main destructive force has been humans through pressure of land use and the destruction of natural resources, but in the second half of the twentieth century a further phase of deterioration is under way due to the massive expansion of tourism in the islands.

Large-scale tourist development (200,000 tourist beds on the island of Gran Canaria alone) brings with it enormous environmental problems. The pressure on coastal region land resources, the constant need for building materials, the strain on local water resources, coastal pollution and disposal of domestic rubbish, and even the damage caused to natural areas by recreational off-road vehicles probably pose the biggest threats to biodiversity and natural resources ever. One of the major, but little-considered, impacts is homogenization of the habitat, the destruction of ecologically well-defined vegetation zones, which leads to species swamping by hybridization (see Brochmann, 1984, for further discussion) and continuously tends toward environmental uniformity and away from diversity.

Faced with such negative effects of human intervention in the environment, the need for an equally interventionist and positive conservation program is obvious.

ENVIRONMENTAL CONSERVATION IN THE CANARY ISLANDS

Conservation in such circumstances is necessarily a multifaceted activity with the following fields of action: legislation (protection of areas, protection of species), planning, research, and education.

Legislation

Protection of the environment is provided for in Spanish law at various levels, from the Constitution to the 1975 Laws on Protected Natural Areas under which the Spanish National Parks were consolidated, and under minor parts of several other national laws on, for example, hunting, mining and mineral extraction, forestry, and water resources. The autonomous regional governments in Spain also have the powers to legislate locally on environmental matters.

National legislation, at least in theory, protects some species. The hunting laws (Ley de Caza art. 23.2, 1970), for example, state that "Species of scientific interest or in danger of extinction will be the subject of special protection . . . ." and under this legislation a royal decree (3181/1980) lists nationally protected species and includes most of the native birds, reptiles, and amphibians of the Canary Islands.

Following Spain's ratification of the Berne and Bonn conventions on the environment and migratory species of wild animals, respectively, many more migratory and visiting birds were added to the list of protected species.

Plant conservation legislation is, however, at individual species level rather less developed and is based mainly on forestry legislation and a series of royal decrees protecting tree species. It does cover the majority of laurel forest species but has proven to be difficult to apply to private landowners. Spanish law does envisage the protection of individual species, and for mainland Spain and the Balearic Islands two decrees from 1982 and 1984 give protection to some wild endemic plants. In the Canary Islands, however, we do not yet have any legislation specifically protecting species other than the forest trees already mentioned.

We have recently prepared a proposed protected species list (Bramwell & Rodrigo, 1982) and this year updated it at the request of the Environmental Department of the Regional Canarian Government with a view to preparing new local legislation for the protection of Canarian endemic plants; we hope that this will take effect during the next 12 months. Draft legislation for a new comprehensive law on environmental protection is also being prepared at the moment, and in 1987 a law was passed placing most of the major areas of conservation importance in the islands in a catalog of protected natural areas (Fig. 4). These cataloged areas are now pending the preparation of individual use and management plans, which is the responsibility of the Dirección General de Medio-Ambiente (Directorate General of the Environment).

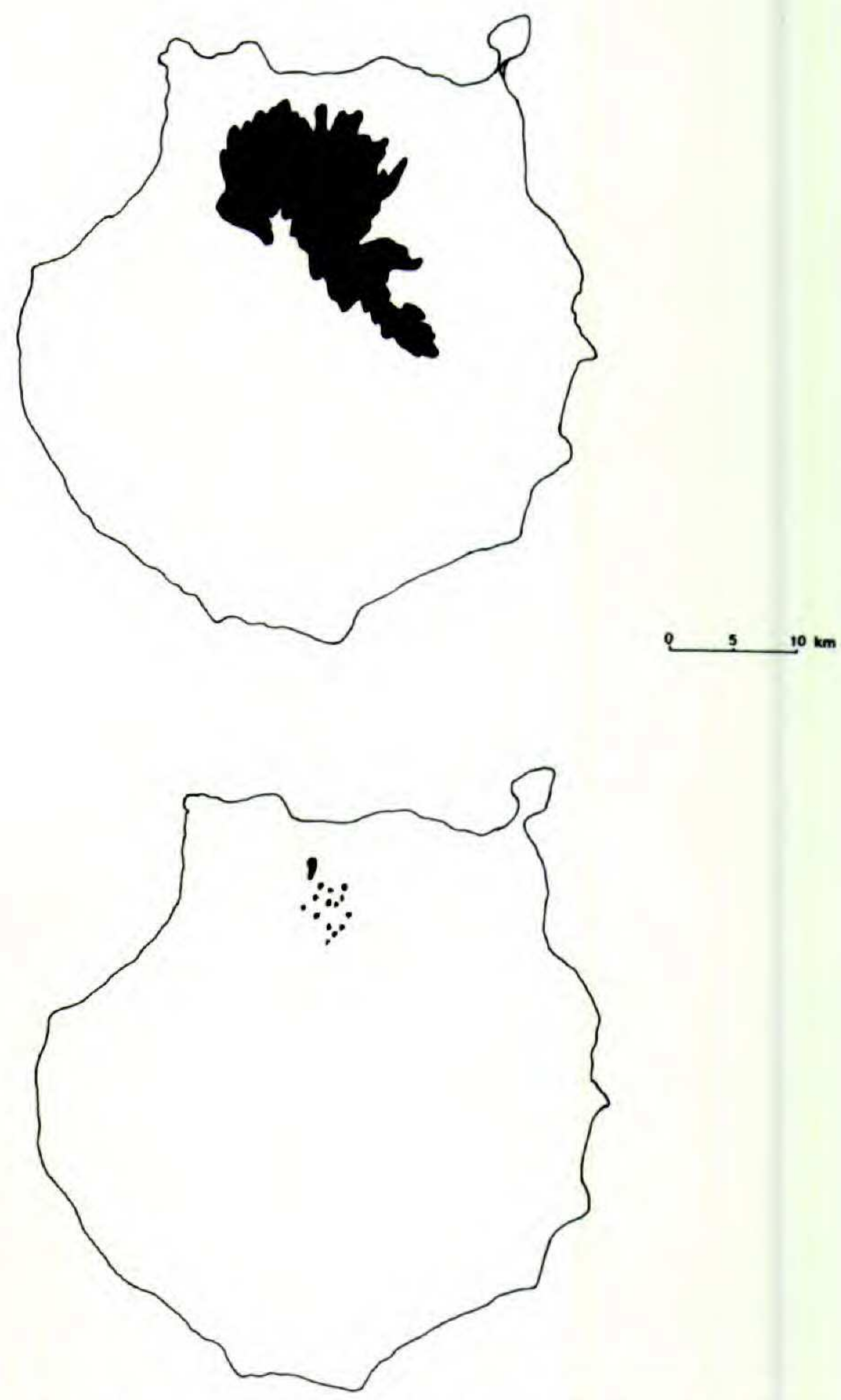

FIGURE 3. Distribution of laurel forest on Gran Canaria. Upper—potential distribution. Lower—actual distribution.

Existing law has been put to good use in the Canaries at two levels, both concerned mainly with in situ ecosystem protection.

At the first level, the international conventions on World Heritage Sites and Man and the Biosphere Reserves have been used to conserve two of the best areas of Canarian laurel forest, El Cedro-Garajonay on La Gomera (Fig. 5), which is also a national park, and Monte del Canal on the island of La Palma. The Canary Islands have four national parks, the subalpine zone of Tenerife (Parque Na-

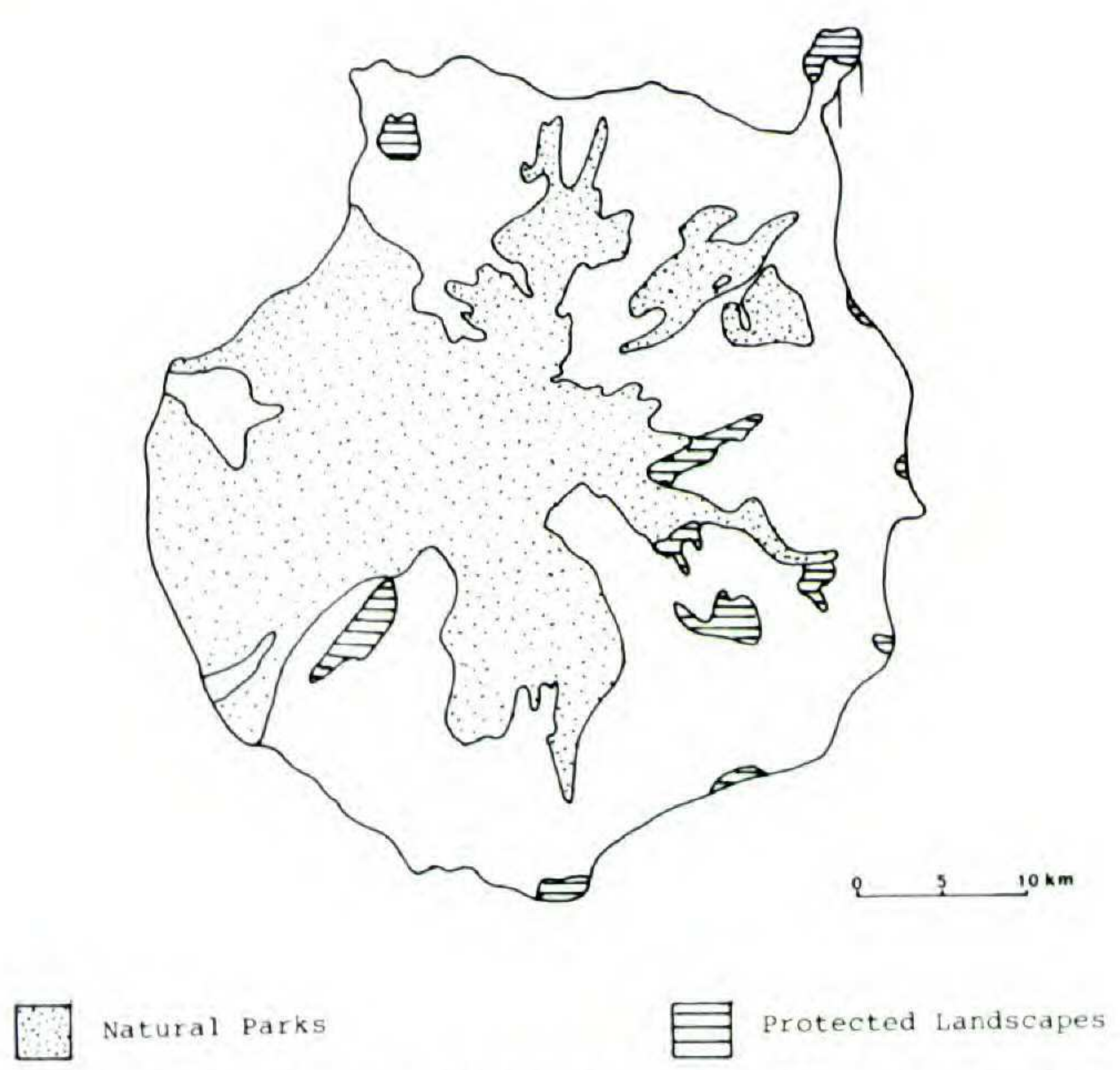

FIGURE 4. Protected areas of Gran Canaria included in the Ley de Espacios Naturales of the Autonomous Regional Government (1987). Dots—natural parks. Lines—protected landscapes.

cional del Teide) covering 13,500 hectares; Parque Nacional de La Caldera de Taburiente on La Palma, which is a pine forest park of 4,690 hectares (ha); the volcano park on Lanzarote (Parque Nacional de Timanfaya) with 5,107 ha; and the already mentioned Parque Nacional de Garajonay with an area of 3,950 ha mainly of laurel forest.

The second level of action in the Canaries has been promoted by the Autonomous Government and the local individual island councils (Cabildos Insulares). Taking advantage of Spanish Town and Country and Country planning law (Ley de Suelos), a series of planning projects classifying land has been undertaken for each island. I explain the one for Gran Canaria in detail as a possible example of the use of planning legislation for natural ecosystem protection on islands.

Planning

Often the philosophy behind the designation of national parks and nature reserves is "monumen-

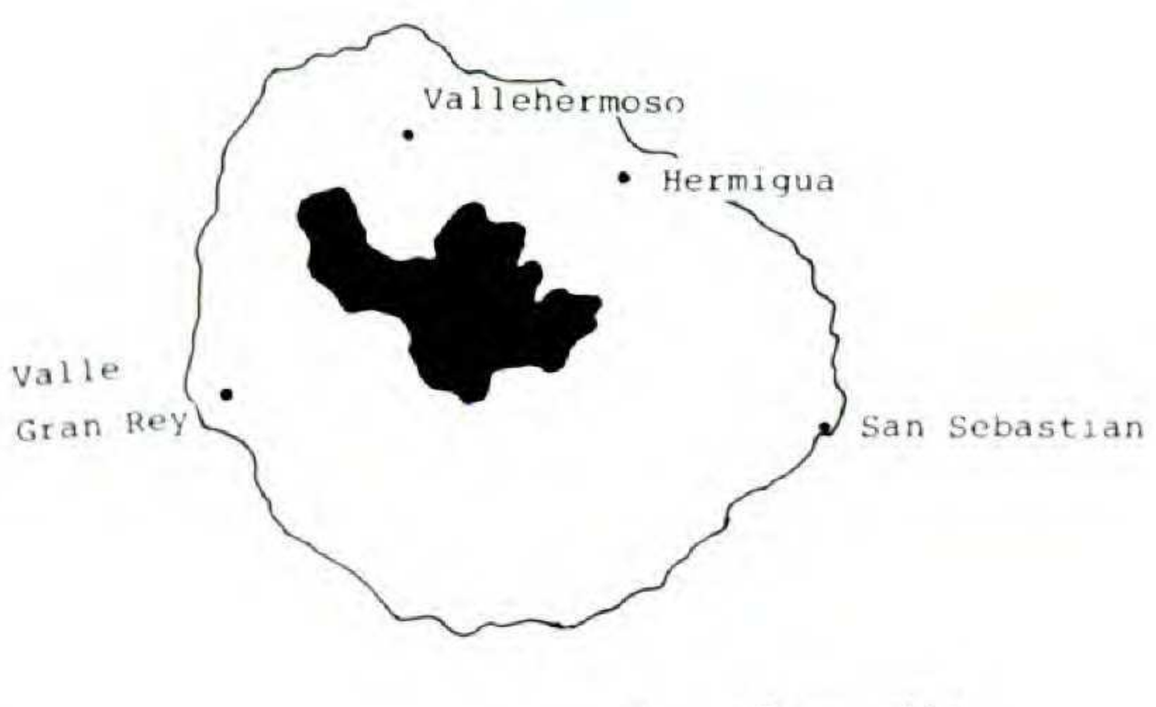

FIGURE 5. National Park of Garajonay, La Gomera, recently accorded the status of World Heritage Site.

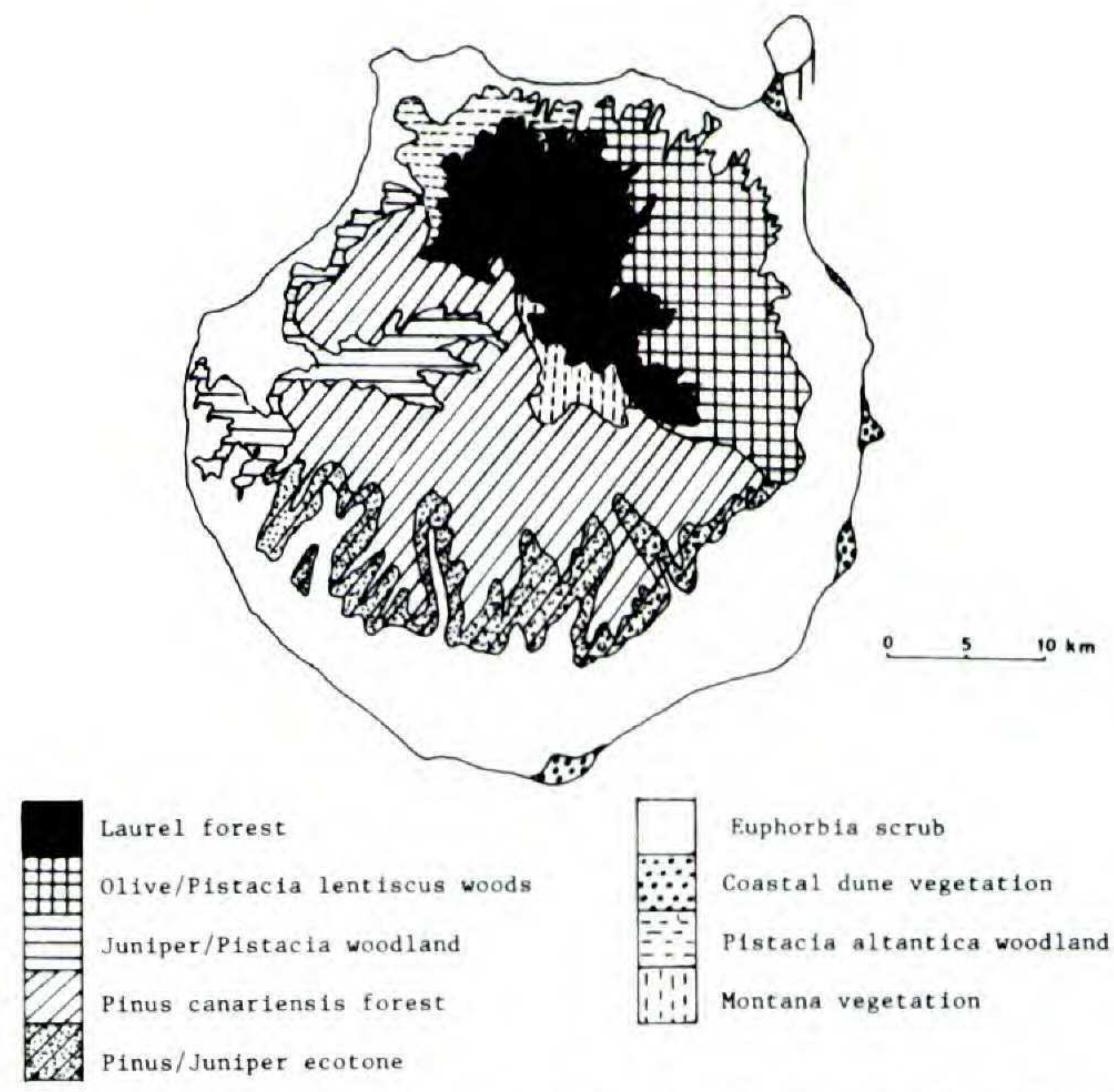

FIGURE 6. The potential natural vegetation of Gran Canaria.

talist" so that great landscapes and so-called wild areas are given priority, and this was certainly true for the original national parks of the Canary Islands, those of Teide, Taburiente, and Timanfaya. These three parks protect only a very small proportion of endangered Canarian endemic species. This was a particular problem for Gran Canaria in the center of the archipelago because it had no national park and very few protected areas in 1983 when the Jardin Botanico "Viera y Clavijo" was asked by the Canarian government and the Cabildo Insular de Gran Canaria to form an interdisciplinary team of biologists, geographers, lawyers, and architects to prepare a special plan for the protection of natural areas under Spanish planning law. The methodology we used was to take a wholly scientific approach to the problem and study the entire island rather than to rely on preconceived ideas about which areas of the island should be protected. In part this was done because previous attempts to delimit natural reserves had failed to protect sufficient areas because they did not consider restoration of degraded areas as a viable conservation policy. A summary of our study of the island has already been published (Bramwell et al., 1986), and I give a brief outline of it here.

The first phase of preparation involved a review of existing information, bibliography, and the experience of members of the team (which was an important source of data). This enabled us to build up a picture of the island leading to the identification of major gaps in our knowledge, some of which were then worked on by the team, and others through the cooperation of outside specialists. The following studies made important contributions to the project:

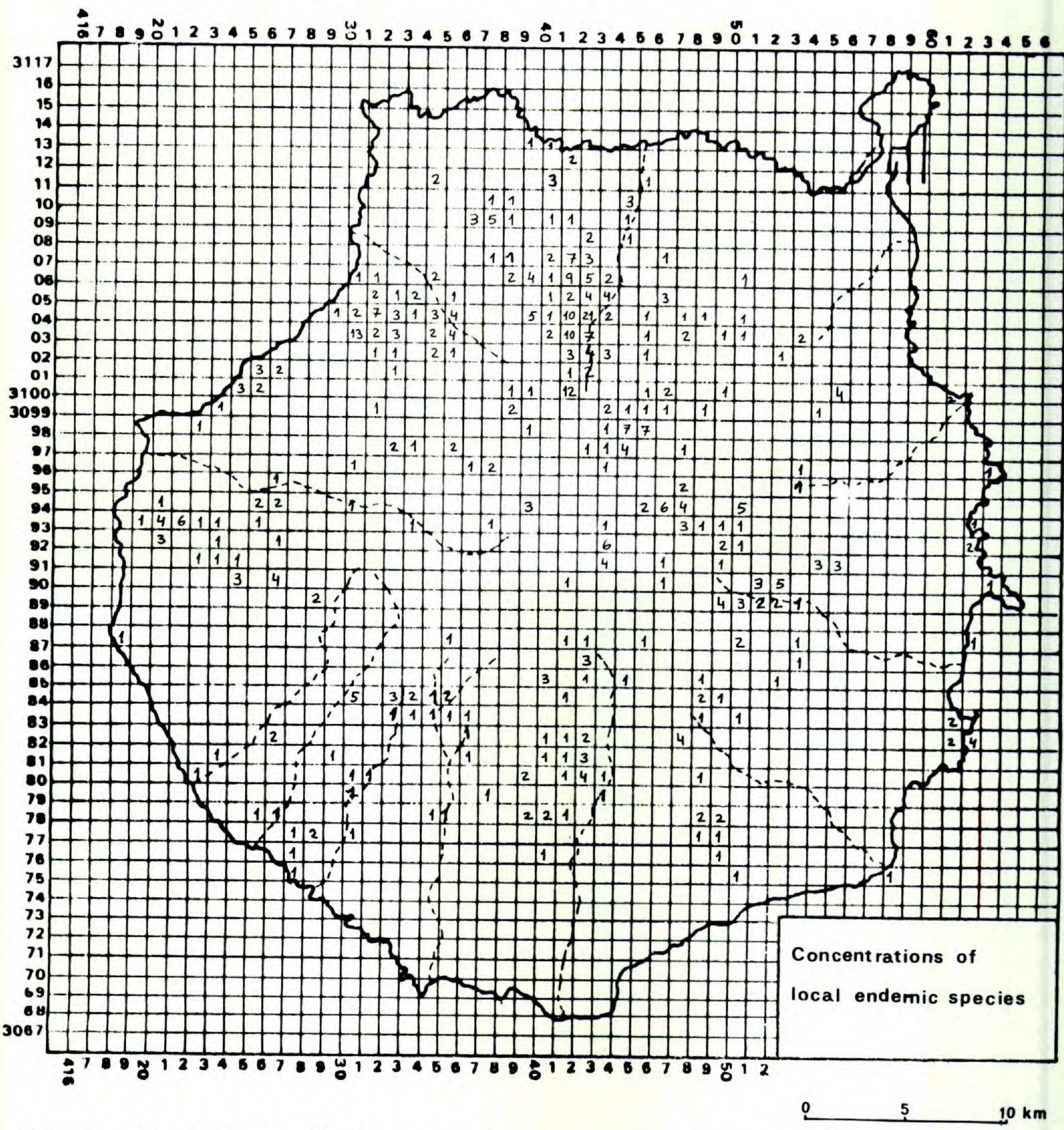

FIGURE 7. The distribution of local endemic species; figures indicate the number of Gran Canarian endemics per km^2.

1. Existing land use. 2. Population distribution. 3. Geomorphological features, mining, and mineral extraction. 4. Areas of ornithological interest. 5. Distribution of native vertebrates. 6. Entomology. 7. Potential (Fig. 6) and actual natural vegetation. 8. Rainfall and water resources. 9. Areas of archaeological interest. 10. Existing town and country planning. 11. Tourist development. 12. Distributions of rare endemic species (Fig. 7).

Only when all this information had been analyzed did we preselect areas that were then subjected to intensive field studies and ranked according to their value as potential protected areas. As a result, and in order to avoid creating what McEwen & McEwen (1982) described as "islets of natural beauty . . . in a sea of destructive practises," we decided it was necessary to give at least some protection to very large areas even though the number of zones needing absolute protection was relatively low.

After detailed mapping of boundaries using aerial photographs, the final number of protected areas was 64, varying in size from 0.5 ha to 14,478 ha and totalling 109,574 ha or approximately 60% of the area of the island (Fig. 8); these protect the main populations of all the endemic plant species as well as the vast majority of birds, reptiles, and insects. The levels of protection proposed are indicated in Bramwell et al. (1986). The Plan Especial has been provisionally approved by the Cabildo Insular de Gran Canaria and has been passed

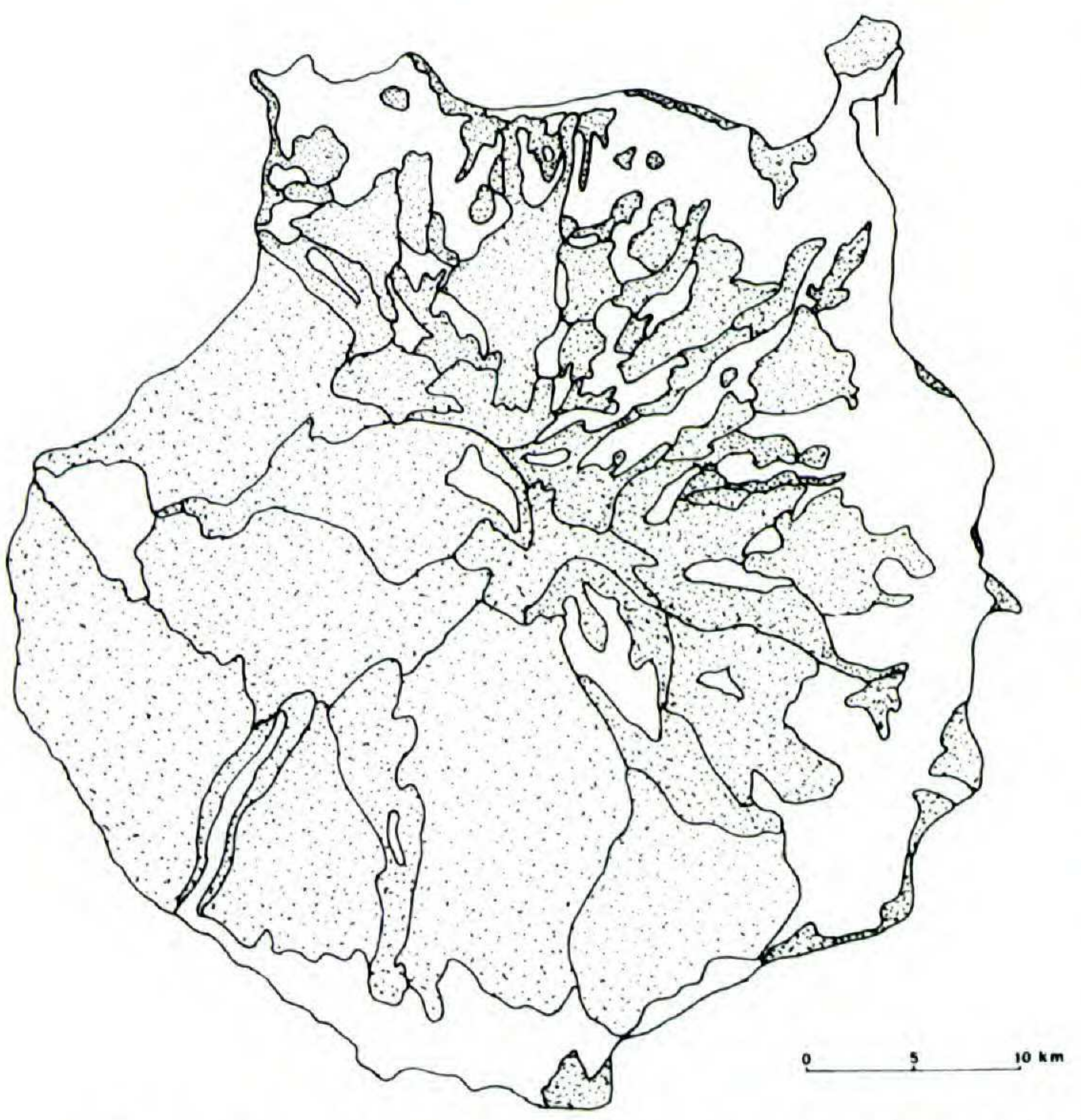

FIGURE 8. Areas proposed for protection in the Plan Especial de Protección de Espacios Naturales (PEPEN) by the Cabildo Insular de Gran Canaria.

on to the Canarian government for definitive approval following which the Directorate General for the Environment will have full responsibility for implementation of the legislation. It is, however, already being used as a guideline document by the Regional Planning Commission for authorization of planning permission. It was also used by the Canarian government's Environment Department as the basis for their 1987 Law on Protected Areas of Natural Interest, although in this case the total area was reduced as some of the areas given a lower level of protection in our plan did not fit into the scale of protection envisaged in the national law.

Conservation research

One of the most important conservation roles for a modern botanical garden involves conservation-oriented research. The fact that many gardens and their staffs have not yet come to grips with this new field does not diminish its importance, as the papers presented at the recent symposium on Botanic Gardens and World Conservation Strategy show (Bramwell et al., 1987). In the Canary Islands, the "Viera y Clavijo" garden was originally set up as a center for the study of the local endemic flora, and over the past few years our work has been mainly directed toward conservation problems and particularly the interface between in situ and ex situ conservation.

Research on individual species

At least 120 of the 500 or so endemic plants of the islands are critically endangered and are potential subjects for conservation-oriented research.

Initial studies have generally involved field observation, distribution mapping, population numbers and size, age structure, and other features leading to a comprehensive picture of the situation of each species in the field. This has been followed by more critical studies of habitat and ecology in many cases. For example, we tried initially to grow the very rare and highly endangered *Lotus kunkelii* in tissue culture, but failed until we carried out detailed studies of its natural substrate and found that the pH reached as high as 8.5 when temporary pools formed in the wet season dried out. We now have cultures of this species growing in a special high-pH medium.

Reproductive biology of many species has also been studied—for example, pollination in some of our extremely rare red- and orange-flowered plants, such as *Isoplexis*, *Lavatera*, *Scrophularia*, *Lotus*, and *Canarina*. Most of these, if they grew on the African mainland, would almost certainly be pollinated by sunbirds (Nectarinidae), but there are no sunbirds in the Canaries. Recent research has shown, however, that several mainly insectivorous birds not usually associated with pollination (*Phylloscopus* and *Sylvia* species) have taken over the role, and pollen samples collected at random from the heads of such birds have been positively identified as coming from such plants as *Isoplexis isabelliana* and *Canarina canariensis*. We have filmed pollination taking place in the natural habitat.

The spectrum of floral structure of bird-pollinated flowers in the Canaries is relatively narrow and does not include the long, narrow-tubed *Aloe* type. Observing the behavior of *Phylloscopus* species on cultivated *Aloe*, we found that it becomes a nectar-thief breaking into the base of the tube because its beak is too short to reach the nectar by normal means and, therefore, does not effectively pollinate long, narrow flowers. The surviving Canary bird-pollinated endemics all have relatively wide throats and short floral tubes.

Since the establishment five years ago of a seed bank for the long-term storage of endemic species, we have been involved in the study of seed production and biology of a considerable number of endangered species. In many cases, for example, *Tanacetum ptarmaciflorum*, where germination is naturally very low (9%), this can be considerably improved (to over 60%), by treatment with gibberellic acid. We now have a large study program on germination and seedling establishment with a view to projects of restocking and reintroduction of species from the seed bank.

The seed bank provides material for a number of other research activities. When samples are removed from the bank for routine germination testing, any seedlings obtained can be used for studies that contribute to our knowledge of the species involved. Plants are grown for karyotype analysis and chromosome behavior, and study of variation, especially if the seed originates from very small, wild populations. Cotyledons, for example, can be used to establish tissue cultures, and seedlings are passed on to the garden nurseries for planting and use in educational displays and other purposes.

Recently conservationists have taken up the flag of biodiversity on a large scale, and in the Canaries this trend has been followed via the establishment of two projects under the name CODIGEN (Conservation of Genetic Diversity).

The first of these is a data-collecting project covering crop–plant relatives and known potential resource species in the Canarian flora. The project is being carried out in three phases.

1. An analysis of the actual situation of each species, distribution, biological cycle, potential and actual reproductive capacity, ecology, state of conservation, and classification according to the IUCN Red Data Book System.

2. Evaluation of each species as a potential resource and the genetic diversity it represents, closeness of relationship to the crop species, known disease resistance or tolerance, possible use in plant breeding, direct uses and scientific value.

3. Recommendations on conservation measures needed to protect each species, minimum number of populations, types of reserve, the need for ex situ conservation in gene banks or living collections, including possibilities for restocking in the natural habitat.

The final report is now available and has been handed over to the Canarian government for consideration in future conservation policy.

The second project is the creation of a conservation model for a single species of major value as a natural resource and for this we chose the Macaronesian endemic grass *Dactylis smithii*, which is a member of the *Dactylis glomerata* (cocksfoot) complex.

The aim of the project, which started in May 1988, is to review the distribution and morphological, ecological, and geographical variation within the species as a first phase and then attempt to study genetic diversity by means of karyology, protein and isozyme analysis, and then select natural variants for recommendation to plant breeders and evaluate the usefulness of this rare species as a forage grass via experimental cultivation. It could become an important species for dry-zone pastures. At the same time, the conservation situation of each natural population will be monitored and recommendations will be made for conservation.

Restoration of vegetation

A new field into which the botanical garden research staff members are also moving is what can broadly be termed restoration biology. This involves, at the simplest level, restocking individuals into an already existing population to increase numbers and variability in the natural population. This has been done successfully during a pilot project funded by WWF/SSC for *Senecio hadrosomus*; plants were grown in tissue culture from explants collected from a range of the surviving wild individuals, and the reintroduced individuals have been monitored over almost two years. Original reintroduction losses were high for this species but surviving individuals are thriving. There is again, however, a need for specialized research in this field if reintroduction is to become a viable means of conservation.

Our attempts to reestablish areas of Canarian laurel forest were successful in that young trees have been reintroduced in former forest areas. Our experience with this showed that in the forest ecosystem the development of the understory layer of shrubs, many of these important and rare endemics (e.g., *Sideritis discolor*, *Isoplexis chalcantha*), depends on the age structure and life cycle of the dominant trees, and the shrub species seem only to be able to establish themselves when gaps occur in the canopy. We need, therefore, to study the age structure of the dominant communities, species density, spatial organization, specialized niches, competition, effects of weeds and exotics, and a whole host of other factors in order to reconstitute ecosystems. Botanical gardens are probably among the most appropriate places for experimental work in this field.

Ecosystem reconstruction is an important subject for conservationists concerned with the floras of small islands, and there is an urgent need for research on restoration biology in island ecosystems.

Finally, I would like to mention micropropagation and in vitro cultivation of endangered species.

The techniques are now well known and are the subject of specialist literature, but their application to propagation of rare plants warrants some comment.

Cloning does not appear to be one of the most appropriate means of conserving genetic diversity, but under certain circumstances it can be a viable tool.

In our approach we have considered in vitro or micropropagation as useful in the following circumstances:

1. For species with chronically very small natural populations where the removal of seed or other propagating material may further damage natural capacity for reproduction and maintenance of diversity. There are in the Canaries several species known only from single localities and with populations of fewer than fifty individuals, for example, *Lotus kunkelii*, *Globularia ascanii*, *Helianthemum bystropogophyllum* (a very distinct species with a known population of less that 10 individuals), and we have successfully propagated several of these in vitro.

2. For species with low natural fertility, either because of genetic problems (pollen and seed viability) or susceptibility to natural predators of pollen or seed. For example, the Flor de Mayo Leñosa (*Senecio hadrosomus*) loses most of its naturally produced seed to larvae of the dipteran fly *Oedosphenella canariensis* (Suárez, 1982).

3. For propagation of species from remote areas when conventional propagating material, such as seed or cuttings, is not readily available.

4. For maintaining dioecious species in cultivation and enabling propagation when plants of only one sex are available. This situation is not infrequent in botanical gardens, and stock can be maintained and propagated for distribution to other gardens via in vitro cultivation.

5. As a means of maintaining germ plasm, especially of species with recalcitrant seeds, over long periods of time (Bramwell, in press).

6. For mass production of horticulturally valuable plants to relieve pressure on wild populations. An example of this is the very rare *Euphorbia handiensis* from the island of Fuerteventura, which is highly desirable for succulent collectors and has been overcollected in the field. We have the species in tissue culture and have propagated it in quantity, and we hope to make plants available to the succulent trade. We may also be able to restock as the natural habitat of the species is now included in the proposed reserves established under the new legislation mentioned previously.

Education

Environmental education is one of the most important aspects of our conservation activities, and we have a substantial program at the garden via organized garden visits and activities and through teacher-training courses, publicity, and extension activities. Two full-time teachers are seconded to the garden by the Education Department of the Canarian government and are responsible for daily visits, audio-visual shows, and a permanent exhibit on different aspects of the flora and fauna of the islands. (Currently there are two major themes, Canarian trees and birds of the Canary Islands.)

Teacher-training courses, particularly, are a very successful means of introducing awareness of environmental problems and conservation of local ecosystems and species into the local education system. Our work in this field was reviewed by Navarro (1987) in *Botanic Gardens and the World Conservation Strategy*.

Open days and public involvement with such projects as tree planting and the use of Canarian plants in local horticulture are also considered to be very productive in making the general public aware of the local flora and its value. From our nursery we supply plants to schools so that they can establish their own small Canarian gardens and to local councils for use in public parks and open spaces. During the next year we are planning to organize a tree planters club among school children to promote small-scale local planting of Canary palms (*Phoenix canariensis*), dragon trees (*Dracaena draco*), laurels (*Laurus azorica*), and other species.

Concluding Remarks

Conservation of biodiversity in the Canary Islands is a substantial subject for a single paper, and I have attempted to give a general picture of the situation and how the activities of one botanic garden fit into it at each level, from providing the scientific basis for legislation and planning to an extensive education program. Such activities require a dedicated team of workers, political and financial support, and the help of national and international conservation organizations. In order to coordinate this, we incorporated our conservation activities into a single project we called "Plantas y Futuro," which could be presented as a package to various funding bodies and for local support. The project covers mainly the field of research, including seed bank, micropropagation, a conservation data base, and the education program. It was successful in obtaining funding at local (Cabildo Insular de Gran Canaria), regional (Gobierno de Canarias), national (Dirección General de Medio-Ambiente del Ministerio de Obras Publicas, Madrid), and international levels through the WWF/IUCN Plants Program, as well as from a local private foundation (Los Palmitos), who donated a microcomputer and a research fellowship for work on *Euphorbia handiensis*.

Much more still needs to be done before we can claim that the future of the Canarian flora and fauna is secured, but we seem to be moving in the right direction. Unfortunately this is still not enough, nor is it on a time-scale that will result in the conservation of many species and ecosystems. However, knowing this should stimulate an even greater effort in the future.

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